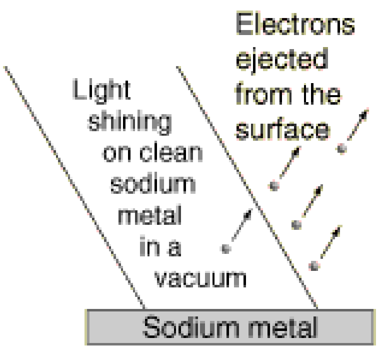
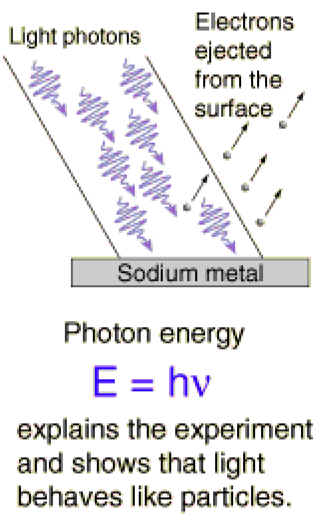
13 Physics AS 91525 Demonstrate Understanding of Modern Physics

BIG Ideas to Remember

Concept: Nuclear Reactions	1. Particles released during spontaneous nuclear decay include alpha ($^4He_2$), beta (e^0_{-1}), protons ($^1p_1$), neutrons (n^1_0) and pure energy gamma too. 2. Nuclear decay processes may be spontaneous, single nucleus decomposition, OR induced artificial decay caused by collision of a smaller and larger nucleus. 3. In all nuclear reactions Conservation of mass number, atomic number, momentum and mass-energy occurs 4. $E = \Delta m c^2$ where $c = 3 \times 10^8$ ms^{-1} (speed of light) 5. The electron-volt is a measure of energy (1.6×10^{-19}J) since $W = \Delta V.Q$
Concept: Nuclear Stability	1. The nucleus' mass is less than the sum of the nucleons' mass. 2. Mass of nucleus includes the energy of the nucleus. Total mass = mass of nucleons + energy of nucleus 3. Mass of each nucleon is less when it is inside the nucleus than when it is free. 4. ***Mass deficit*** is the reduction of mass when the nucleons form the nucleus. 5. ***Binding energy*** is the amount of energy which must be supplied to make up mass deficit when the nucleus is broken up,
Concept: Binding Energy; Fission and Fusion	1. ***Binding energy per nucleon*** shows the strength of the nuclear glue. 2. Increased binding energy per nucleon means increased stability of the nucleus (Fe^{56}_{26} is most stable nucleus). 3. Nuclei with the lowest mass per nucleon have the biggest binding energy and their nucleons have the lowest energy. 4. Fission occurs when a large nucleus is split into smaller nuclei and a large amount of gamma radiation energy is released. 5. Fusion occurs when two light nuclei join together and a large amount of gamma radiation energy is released.
Concept: Electrons in the Atom and Energy Levels.	1. Light given out by excited low-pressure gases can be diffracted to form emission spectrums of converging lines. 2. An absorption spectrum is caused by white light shing on a gas and causes dark spectral lines that converge. 3. The Hydrogen atom's spectral lines represent transitions between energy levels that are related by $1/\lambda = R(1/S^2 - 1/L^2)$ where S is the series number and L is the line number. 4. The series are Lyman u.v. S = 1 Balmer visible S = 2 Paschen infra-red S = 3 Brackett infra-red S = 4 Pfund infra-red S = 5 5. The limiting wavelength represents the energy to remove electrons from atoms (ionise the atom)
Concept: Bohr's Model of the Atom	1. $E = hf$ and $\lambda = c / f$ ($c = f\lambda$) 2. $E = hcR/S^2 - hcR/L^2$ and represents the energy difference between two energy levels 3. Electrons in the Hydrogen atom can only exist within energy levels given by $E = -hcR/n^2$ 4. Electrons with zero energy will leave nucleus (ionisation occurs) 5. An atom's energy levels can be described by the Principal Quantum Number, n = 1,2,3….,

Explaining the Emission Spectrum	1. Each series of lines in the Hydrogen atom's spectrum represents the energy released when electrons "fall" froma higher energy level to a lower energy level. 2. The series are called Lyman, Balmer, Paschen, Brackett and Pfund 3. The smallest energy release for any of the series is significantly greater than the largest energy drop of the next series. 4. The energy released is directly proportional to the frequency of the emitted photon 5. Photons are 'packets of light energy' with discrete, measurable frequency and energy: E = hf
The Photo-electric Effect	1. The Photo-electric Effect is the emission of electrons from zinc or sodium metal's surface when light shines on the surface of the metal. 2. Brighter light causes more electrons to be released but does not change the energy of the electrons emitted. 3. Ultra-violet light causes instantaneous release of electrons. 4. Higher frequency of incident light releases emitted electrons with greater energy. 5. E = hf for photons, so light shining onto the metal surface can be thought of as a continuous stream of energy particles and tis energy is transferred to the electrons in the surface of the metal.
The Photo-Electric Effect and Wave-Particle Duality	1. If the energy transferred from the photons is just enough to release electrons from the surface (just equal to the Work function) then electrons will be released. 2. If the energy of the photons is more than is needed to release the electron. Then the electron will be emitted with kinetic energy, E_k. 3. Brighter light means more photons, so more electrons will be emitted by the metal's surface. $E_k = hf - \phi$ where E_k is kinetic energy, hf is photon's energy, ϕ is Work function 4. Light of a particular frequency can be modelled as an electro-magnetic wave of a particular, very small wavelength, and this wave travels at a very high speed, c. 5. Light can also be modelled as photons that have both wave and particle properties (wave – packets) and the photon has a measureable, fixed value of energy (E = hf, & E = hc/λ)





Einstein's General and Special Theory of Relativity	1. After light has left a source, its motion cannot be influenced by the motion of the source; so the speed of light in a vacuum is independent of the motion of the source. 2. The rate of time apparent on a moving object seems to be slower than the rate of time in another stationary situation, as seen by a person in this stationary situation. 3. The length of a ruler that is moving at a high speed appears to be shorter than it is when it is stationary, as seen by a stationary person. 4. The mass of an object seems to increase as the mass approaches the speed of light, as seen by a stationary observer. 5. The Lorentz Transformation describes the relative changes in time, length and mass.
Qualitative Treatment of Quarks and Leptons	1. The Standard Model tries to explain what the world is and what holds it together. 2. All the known matter particles are composites of quarks and leptons, and they interact by exchanging force carrier particles 3. Physicists have discovered that **protons** and **neutrons** are composed of even smaller particles called **quarks**. 4. The Standard Model of the Atom explains that the atom is made up of Fermions including only 6 Quarks and 6 Leptons (the electron is one of the Leptons). 5. Also there are five Force Carrier "Bosons" including the Higgs Boson, the gluon and the Photon